

# **Nitrous Oxide Emissions from Agricultural Soils in California -An Overview-**

ARB Joint Research Seminar

Research Division  
California Air Resources Board

November 28, 2012

# Today's Presentation:

- I. Assessing Greenhouse Gas Emissions in California Cropping Systems

*Prof. William Horwath, University of California, Davis*

- II. Greenhouse Gas Mitigation Options for California Agriculture

*Prof. Johan Six, University of California, Davis*

- III. Methodology and Challenges for Measuring and Modeling Nitrous Oxide Emissions from California Cropping Systems

*Prof. Dave Goorahoo, California State University, Fresno*

# AB 32: California's Landmark Legislature

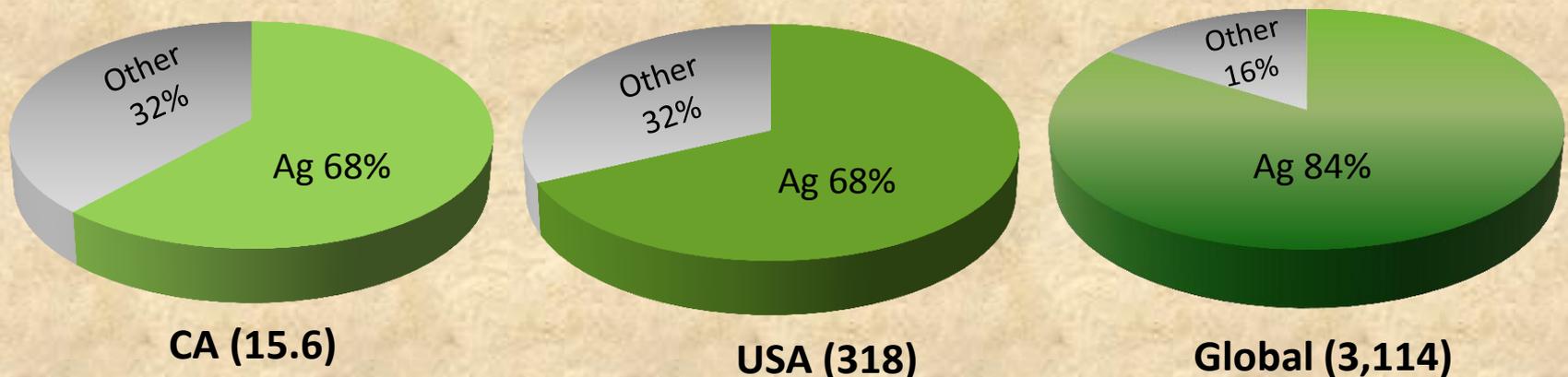
- The Global Warming Solution Act of 2006
  - ❑ Reducing greenhouse gas (GHG) emissions to 1990 levels by 2020
  - ❑ About 30% reduction from business-as-usual emission levels projected for 2020
  
- AB 32 Scoping Plan: California's road map to AB 32 goal
  - ❑ Early action measure: *“Collaborative research to understand how to reduce GHG emissions from nitrogen land application”*
  - ❑ Identify control variables and explore emission reduction opportunities

# Overview of N<sub>2</sub>O

- Six Kyoto greenhouse gases
  - ❑ CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCs, PFCs and SF<sub>6</sub>
- Global Warming Potential (GWP)
  - ❑ 100-year GWP of N<sub>2</sub>O = 298
- N<sub>2</sub>O produced naturally and artificially
  - ❑ Natural processes: nitrification/denitrification and combustion
  - ❑ Artificial reaction: catalytic chemical oxidation (chemical manufacturing)

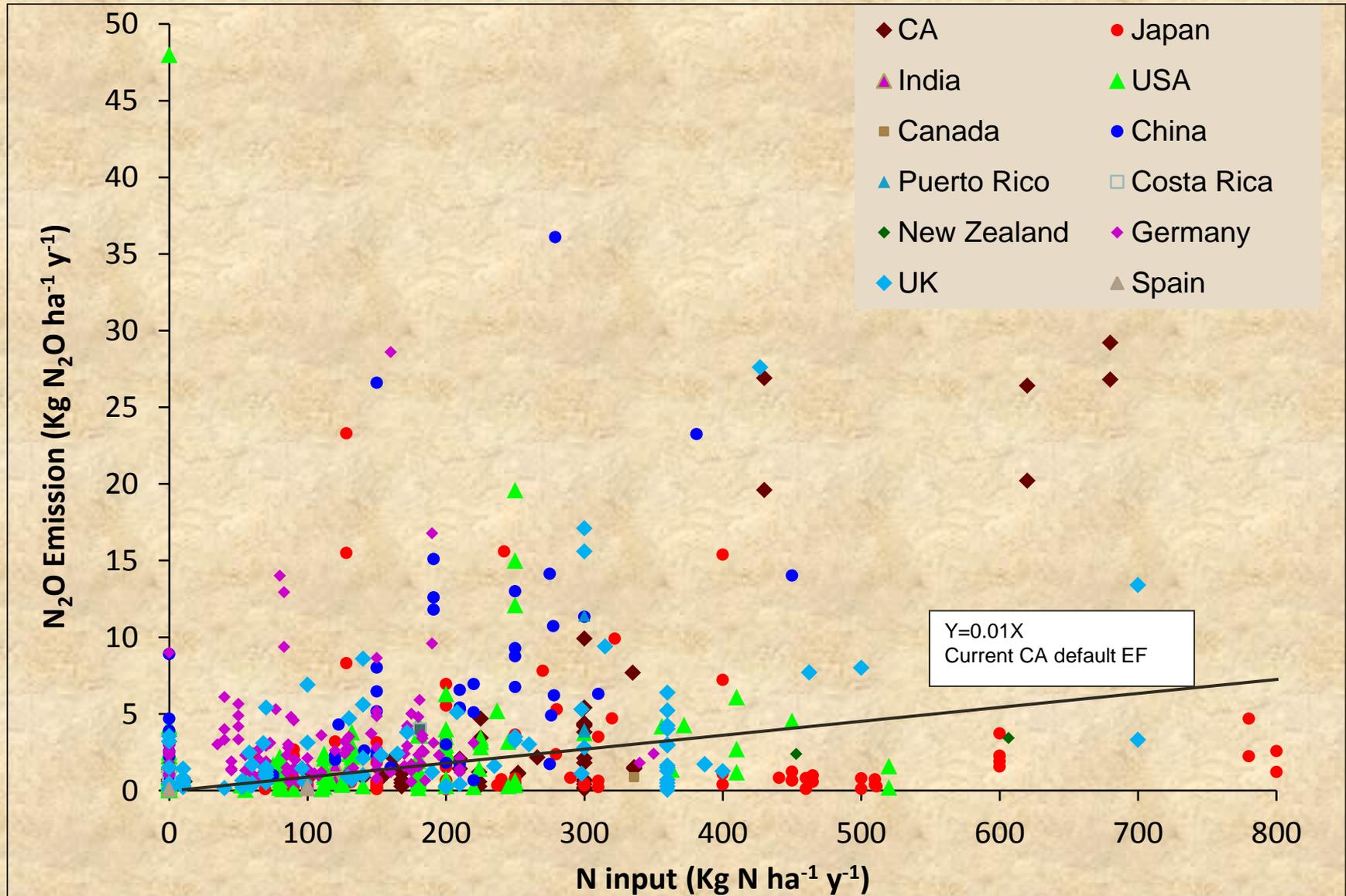
# Significance of N<sub>2</sub>O Agricultural Emissions

- Largest contributor of anthropogenic N<sub>2</sub>O N<sub>2</sub>O inventory (total, MMTCO<sub>2</sub>E):



- 90% of agricultural N<sub>2</sub>O emissions from agricultural soil management

# Observed N<sub>2</sub>O Emission Rates from Field Experiments



# California Statewide Efforts

- Multiple State Agencies:
  - ❑ California Air Resources Board (CARB)
  - ❑ California Energy Commission (CEC)
  - ❑ California Department of Food and Agriculture (CDFA)
  - ❑ California Department of Resources, Recycling, and Recovery (CalRecycle)
  
- Total funding committed: \$2.9 million
  - ❑ Phase I: Baseline N<sub>2</sub>O emissions
  - ❑ Phase II: Mitigation measurements
  - ❑ Model improvement

# N<sub>2</sub>O Working Group

- Overseeing N<sub>2</sub>O research program
- Coordinated through San Joaquin Valley Agricultural Technical Committee
- Consisting of growers, academic researchers, fertilizer industry representatives, and federal (US EPA, USDA), state, and local government agencies
- Stakeholder meetings
  - ❑ *Research priorities*
  - ❑ *Technical issues*
  - ❑ *Project updates*

# List of N<sub>2</sub>O Research Projects in California

| Agency             | Funding   | Objectives                        | Period    | PI          | Affiliation      |
|--------------------|-----------|-----------------------------------|-----------|-------------|------------------|
| ARB                | \$300,000 | Baseline: Field, Row crops        | 2009-2012 | W. Horwath  | UC Davis         |
| ARB                | \$82,000  | Baseline: Field, Dairy            | 2010-2014 | W. Horwath  | UC Davis         |
| CEC                | \$500,000 | Baseline: Field, Tree crops       | 2009-2012 | J. Six      | UC Davis         |
| CDFA               | \$150,000 | Baseline: Field, Row crops        | 2009-2012 | D. Goorahoo | CSU Fresno       |
| CalRecycle         | \$450,000 | Baseline: Field, Organic waste    | 2010-2013 | W. Horwath  | UC Davis         |
| ARB                | \$250,000 | Modeling                          | 2011-2014 | C. Li       | U. New Hampshire |
| Packard Foundation | \$350,000 | Mitigation: Field, Tomatoes       | 2009-2011 | J. Six      | UC Davis         |
| ARB                | \$400,000 | Mitigation: Field, Row crops      | 2012-2015 | M. Burger   | UC Davis         |
| USDA               | \$745,000 | Mitigation: Field, Row&Tree crops | 2012-2016 | W. Horwath  | UC Davis         |

# Major Crops Studied in California

| Acreage rank | Crop                 | Acreage (1000 acres) | Value (\$million) | Economic rank |
|--------------|----------------------|----------------------|-------------------|---------------|
| 1            | Hay (mainly alfalfa) | 1470                 | 971               | 12            |
| 2            | Nuts                 | 1104                 | 5059              | 1             |
| 3            | Grapes               | 792                  | 3201              | 2             |
| 4            | Rice                 | 553                  | 789               | 9             |
| 5            | Wheat                | 455                  | 226               | >15           |
| 6            | Tomatoes             | 308                  | 1274              | 8             |
| 7            | Cotton               | 303                  | 610               | >15           |
| 8            | Lettuce              | 207                  | 1642              | 7             |
| 9            | Corn                 | 180                  | 183               | >15           |

# California-Specific Emission Factors

| Crop    | Annual N Rate (Kg N/ha) | Management                     | Emission Factor (%) |
|---------|-------------------------|--------------------------------|---------------------|
| Tomato  | 75-300                  | Baseline                       | 1.5                 |
| Lettuce | 11-336                  | Baseline                       | 0.54                |
| Wheat   | 91-266                  | Baseline                       | 0.57                |
| Alfalfa | 8.5                     | Baseline                       | 8.1                 |
| Rice    | 140-224                 | Wet seeding, conventional till | 0.29                |
|         |                         | Dry seeding, no till           | 0.65                |
| Almonds | 230                     | Baseline                       | 0.35                |

# On-going Projects and Research Planning

## ➤ On-going projects

- ❑ Mitigation: Subsurface drip irrigation, nitrification inhibitor, conservation tillage, modified N fertilizer application (type, spatial allocation, fertigation), organic farming
- ❑ Modeling: Parameterizing process-based mechanistic models (DNDC, Daycent, etc.)

## ➤ Work plan under development

- ❑ Reducing N<sub>2</sub>O inventory uncertainty
- ❑ Reconciling inverse modeling results with current inventory estimates